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Model Predictive Control with Integral Action for Current Density Profile Tracking in NSTX-U[1] Z.O. ILHAN, W.P. WEHNER, E. SCHUSTER, Lehigh University, M.D. BOYER, PPPL — Active control of the toroidal current density profile may play a critical role in non-inductively sustained long-pulse, high-beta scenarios in a spherical torus (ST) configuration, which is among the missions of the NSTX-U facility. In this work, a previously developed physics-based control-oriented model is embedded in a feedback control scheme based on a model predictive control (MPC) strategy to track a desired current density profile evolution specified indirectly by a desired rotational transform profile. An integrator is embedded into the standard MPC formulation to reject various modeling uncertainties and external disturbances. Neutral beam powers, electron density, and total plasma current are used as actuators. The proposed MPC strategy incorporates various state and actuator constraints directly into the control design process by solving a constrained optimization problem in real-time to determine the optimal actuator requests. The effectiveness of the proposed controller in regulating the current density profile in NSTX-U is demonstrated in closed-loop nonlinear simulations.

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